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ABSTRACT

Collaboration in the classroom is a major theme of educational reform today. Electronically-supported conversation (ESC) is one way of using technology to support collaboration in the classroom. ESC offers several instructional benefits over simple spoken discourse. We describe a simple model ("two cans and a string") for how ESC could work in the classroom. A software program entitled "e-talk" implements the "two cans and a string" model. The features of the program are described, and techniques are presented to demonstrate how the program works. Several examples are provided of instructional activities based on ESC using the e-talk program. E-talk is not the first program developed for ESC; nor is ESC the only way of supporting collaborative work in the classroom through groupware. Nonetheless, the paper presents arguments for two claims. First, it is argued that ESC may provide benefits not only in teaching writing, but also in collaborative teaching in general. Second, the model underlying e-talk (i.e., "two cans and a string") is sufficiently flexible to serve as a basis for further experimentation into the uses of ESC in collaborative instruction. Four figures illustrate the discussion. (Contains 31 references.) (Author)

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Two Cans and a String:
A Metaphor for Electronically-Supported Conversation in Collaborative Instruction[1]

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ABSTRACT

Collaboration in the classroom is a major theme of educational reform today. Electronically-supported conversation (ESC) is one way of using technology to support collaboration in the classroom. ESC offers several instructional benefits over simple spoken discourse. We describe a simple model ("two cans and a string") for how ESC could work in the classroom. A program entitled "e-talk" implements the "two cans and string" model. The features of the program are described and techniques are presented to demonstrate how the program works. Several examples are provided of instructional activities based on ESC using the e-talk program. E-talk is not the first program developed for ESC; nor is ESC the only way of supporting collaborative work in the classroom through groupware. Nonetheless, the paper presents arguments for two claims. First, it is argued that ESC may provide benefits not only in teaching writing, but also in collaborative teaching in general. Second, the model underlying e-talk (i.e., "two cans and a string") is sufficiently flexible to serve as a basis for further experimentation into the uses of ESC in collaborative instruction.

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In the traditional, teacher-centered classroom, the model of instruction is one of delivery—the teacher identifies a body of information and delivers it to the student in the form of lectures, reading assignments, work sheets, and so forth. The student serves as a passive recipient of the proscribed body of information. The crucial relationship, therefore, is the one that occurs between the teacher and the learner. The presence of other learners is at best irrelevant and may actually be viewed as a deterrent to learning.[2]

In stark contrast, more recently introduced methods of instruction tend to emphasize the importance of the social context in instruction. These methods arise within a different tradition, one of collaborative and student-centered learning. Examples of such methods would include: cooperative learning (Slavin, et. al., 1985), project-based instruction (Blumenfeld, et al., 1991), problem-based learning (Barrows & Tamblyn, 1980) and reciprocal learning (Palincsar & Brown, 1984). Although these methods assume quite different forms, they share a dependence on active interaction among members of the learning group as they work to complete a specified task. This paper will explore ways in which a particular form of technology, the electronically-supported conversation (ESC), can be used to enhance learning within these collaborative and student-centered forms of instruction.

Electronically-supported conversation is a form of computer-mediated communication (CMC) in which participants exchange data electronically. Typically each participant in such an interaction will sit before a networked workstation. They may be co-located or dispersed, although this discussion will focus primarily on groups of learners working together at a common site. ESC differs from electronic mail (another form of CMC) in that ESC is a *synchronous* form of communication, whereas e-mail is *asynchronous*.[3] Electronically-supported conversation has been used extensively in the past, particularly in composition and

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[2]The "gold standard" for instruction within the teacher-centered tradition is the one-to-one tutorial (Bloom, 1984). The effectiveness of any method of instruction within this tradition can only asymptotically approach that of the individualized tutorial. For obvious practical reasons, however, it is not feasible to employ one-to-one instruction as a general method of education. Teaching in groups, therefore, is simply a compromise necessitated by economic considerations.

[3]A telephone conversation is a paradigmatic example of synchronous communication; letter writing is an example of asynchronous communication. The distinction hinges on whether or not the interaction is coordinated in real time.

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writing instruction (Bruce & Peyton, 1991; Hawisher & Selfe, 1989). It is discussed in the literature under a variety of names including: real-time conferencing, synchronous CMC (Hawisher, 1992), and ENFI (for "Electronic Network for Instruction" (Batson, 1988)).

This paper will first explore the rationale for introducing ESC into the classroom. It will then describe a simple model ("two cans and a string") for conceptualizing how an electronic conversation works. We will describe a program, known as "e-talk," that implements this simple model. Some important techniques of electronically-supported conversation will be described, as will some examples of instructional methods that depend on ESC.

What does ESC afford to the classroom?

The idea of using computers to support conversation within the classroom may seem at first counterintuitive. Why type when you could more easily (and much less expensively) talk? Four benefits which we consider most important are as follows:

- *Private channel in a public forum.* Discussion in a traditional classroom is sequential—"Raise your hand and I will call on you." The quality and quantity of ideas expressed may be limited by the effects of group dynamics. Phenomena such as domination by one or more members, "free-riding", and sequence effects may lead to the suppression of otherwise useful group input (Salomon & Globerson, 1989). The presence of networked computers makes possible a form of parallel, private communication which will overcome these limitations (Koschmann, Feltovich, Myers, & Barrows, in press).
- *A retrievable record of the group's deliberations.* Collaborative methods depend upon the exchange of information in group meetings. Records of the group's deliberations are particularly useful when the group attempts to reflect upon the process (i.e., perform an "abstracted replay" (Collins, Brown, and Newman, 1989)) or when they wish to contrast the current task to prior work (Bransford, Franks, Vye, & Sherwood, 1989). Unfortunately, maintaining accurate records of the group's deliberations can be costly in terms of time and effort. ESC, however, can be readily captured, reproduced and stored archivally, providing an easily retrievable record for future reference.
- *Better articulation of newly acquired knowledge.* Articulation of newly acquired knowledge has been shown to enhance retention (King, 1992), promote better

understanding (White, 1984), and to aid in the abstraction of crucial principles (Larkin, 1989). Research has demonstrated that typed text tends to be more succinct, complete and contains less redundant information than spoken discourse (Chapanis, 1988). It seems reasonable, therefore, if articulation leads to more effective learning, then more thoughtful and complete articulation should further enhance learning.

- *More honest critiquing of the work and ideas of peers.* Collaborative methods require students to critically assess their own knowledge, their sources of information, and the contributions of their peers. Providing honest feedback to their classmates is difficult for many students. However, students may find it easier to express their opinions electronically (Hartman, et al., 1989). ESC, therefore, provides a form of "scaffolding" (Collins, et al., 1989) that enables students to provide more pointed and valid feedback.

e-talk: A Tool for Electronically-Supported Conversation

Most computer programs for tasks such as numeric calculation or word-processing, are designed to be used by an individual working alone. When collaborating individuals wish to share data they utilize mechanisms such as electronic mail or file servers. It would be an overstatement to characterize such exchanges as "conversations", however. What does it actually mean to conduct an "electronically-supported conversation"? By way of an answer, consider the simplest possible communication technology—two cans and a string. As children, many of us experimented with gear of this sort to communicate with playmates over short distances. If the string is attached to the bases of two empty tin cans and then stretched taut, one person speaking softly into one of the cans (that is, the "talking can") can be heard by another person listening with the other can (the "listening can").

We have developed a program, known as "e-talk", that produces an analogous form of communication. This is achieved through use of screen-based windows. The program uses two kinds of windows—dispatch windows and listener windows. Like the "talking can", dispatch windows are used to transmit material from one workstation to another. Listener windows, as the name might imply, are used to receive material, not unlike the "listening can."

When a user creates a dispatch window in the e-talk program, s/he is asked to specify to which listener window(s) the new dispatch window should be connected.

Point-to-point connections can be created by specifying a particular listener window. Alternatively, dispatch windows can be set so that they will broadcast their dispatches to all known listener windows.[4] Once created, the dispatch window operates much like a conventional word-processing window—a user can freely enter and edit text. When "dispatched", the contents of the window are transmitted to all its connected listener windows. Following a dispatch, the window is cleared to provide space for composing the next dispatch.

New material dispatched to a listener window is appended to the previously received material in the window. Listener windows, like dispatch windows, function as simple word-processing windows (i.e., their contents can be modified or deleted, new text can be added). This is useful for annotating material that has been received.

Although listener and dispatch windows offer simple word-processing capabilities, they are mostly intended to be used as a vehicle for transmitting material to other users. It is anticipated that users of the e-talk program will, for the most part, be working in other programs on their workstations (e.g., word-processing, spreadsheet, electronic mail programs), and will import material from these programs into dispatch windows when they wish to transmit it to co-workers. Using this mechanism, for example, participants in a conversation could include sketches and images within their dispatches.[5]

Although not required by the e-talk program, it is often advantageous to have a projection system which can be used to project the contents of one of the screens. Under these circumstances, each participant then views two screens—a private screen upon which s/he conducts his/her work, and a shared screen which is visible to all members of the group. The shared screen can be used as a public display space, in much the same way that blackboards, flip charts, and overhead projectors are used in a conventional meeting room.

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[4]Specific listener windows can be declared to be "non-broadcast." Non-broadcast listener windows will only receive dispatches explicitly sent to them via point-to-point connections and will not receive broadcast dispatches.

[5]We consider this capability to be very important when supporting learning groups, because in the process of learning and problem-solving, participants may require a less structured representation than text for expressing their ideas (Goel, 1992).

Some Useful Techniques for Conducting Electronically-Supported Conversations

There are a number of useful techniques for synchronized computer-mediated communication. At any given time, a group may employ one or more of these techniques to achieve its goals. Since each participant may have any number of dispatch and listener windows, it is possible to employ multiple techniques simultaneously. The basic ways of using the e-talk program are as follows:

Dedicated Channels. The simplest form of ESC is achieved by establishing a dedicated communication channel between two users' workstations. As shown in Figure 1, this is done by having each of the users create dispatch windows with explicit, point-to-point connections to each others' listener windows. To keep their listener windows from becoming filled with broadcast dispatches from other users on the network, the listener windows used in a dedicated channel are usually declared to be non-broadcast. Dedicated channels are not limited to two interactants—multiway conversations can be supported by extending the dedicated channel to include additional users. Each participant's dispatch window must be explicitly connected to listener windows for all of the other participants in the conversation. Maintaining these explicit connections can become cumbersome as the group grows larger. Under these circumstances, it is often more convenient to use the "open-forum" communication technique.

Open-Forum Communication. We term a configuration in which all users have broadcast dispatch windows (see Fig. 2) an "open-forum" configuration. Open-forum configurations offer a simple approach to producing multi-way discussions. Material dispatched by each group member is interwoven as it becomes appended to the material previously captured in each user's listener window. Each participant can freely manipulate her/his view of this discussion (e.g., scroll backwards and forwards, annotate or edit it). One advantage of open-forum configurations is that they dynamically adapt as participants enter and leave the conversation, without requiring the users to explicitly modify the connections among windows.

Chauffeured Meetings. Johansen (1989) described a method for facilitating face-to-face meetings that he termed "chauffeured meetings." In a chauffeured meeting, one member of the group, termed the "facilitator" or "scribe," produces a representation of the group's work as the meeting progresses. The representation may be an outline, a sketch, a data base, or any other appropriate summation of the group's deliberations. As shown in Figure 3, a chauffeured meeting can be conducted by having each participant create a dispatch window with a point-to-point

connection to the facilitator's listener window.[6] To allow all participants to view the shared artifact upon which they are working, it is often helpful to project the scribe's screen so that it can be viewed by the entire group.

Some ESC Teaching Activities using e-talk

The three ESC techniques described in the previous section can be used alone or in combination to meet the instructional requirements of a particular instructional activity. The following is a (by no means exhaustive) list of instructional activities which could be conducted using ESC.

Devil's Advocate. Neuwirth, Palmquist, and Gillespie (1989) described a teaching method they call "devils advocate" which could easily be implemented using dedicated channels of communication. The method they describe was designed to help students develop skills in persuasive writing, although it could be readily applied in a host of other domains in which critical thinking is valued.

Students are assigned in pairs to critique each other's work. One student presents a piece of work (e.g., essay, design proposal, theory) and the other student, playing the role of critic, tries to identify weaknesses and flaws. The presenting student then proposes revisions to the original work which answer the criticisms. The chief benefit of doing this exercise using ESC is that a transcript of the discussion is produced automatically. This transcript can be used by the presenting student to assist in making later revisions to the presented work.

Role Playing. Devil's advocate is just one example of a way in which role playing can be used in conjunction with ESC. Role playing in general can be used to enable students to explore various political, social and ethical issues. The structure of the exercise is very simple. A scenario is proposed, students are divided into pairs and assigned a role to play. The possibilities for scenarios are virtually limitless. Bruce and Peyton (1991) described a class activity based on the topic of the destruction of the Amazon rain forest in which students were assigned roles such as "environmentalist" or "land baron." Kremers (1989) described another scenario designed to interest students in the plight of Armenian earthquake victims.

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[6]In Johansen's description of a chauffeured meeting, only the facilitator works with a computer. However, when using e-talk, each participant can work at their own computer. The facilitator's job is converted from one of constructing the shared artifact from scratch to one of cutting and pasting contributions submitted by group members.

Medical students could be asked to portray a practitioner interviewing a patient on an embarrassing or difficult topic. Role playing can be a very engaging activity. Furthermore, by giving students advance notice of the role that they will be expected to play, the exercise can have a component of self-directed learning.

There are several benefits of using ESC for role playing activities. Because electronic conversation is silent, multiple pairs of role players can be present in the same room without distracting each other. Students may more freely assume alternative roles through the keyboard. The transcript of these role playing sessions can be later analyzed by the group, leading to fruitful discussions.

Computer Talk. One of the simplest ways of using ESC is to have all members of a group conduct a conversation using open forum communication. Examples of instructional activities that could be achieved using this form of interaction include role playing with more than two participants (Kremers, 1989) and progressive text production (Simpson, 1989). Computer talk can also be used to facilitate brainstorming sessions, analytic discussions and critiquing of student work.

Dialogue conducted through ESC has the benefit of automatically producing a transcript. Students may find it easier to keep on task when they are required to type their contributions to a conversation, as opposed to simply conducting the conversation through spoken discourse.

Parallel Polling. Parallel polling is a strategy for soliciting unbiased responses from members of the group. It can be used in conjunction with teaching methods which depend upon group problem solving (Koschmann, et al., in press). At appropriate junctures, the instructor (moderator) queries the group and requests each student to respond privately via the network. The instructor may, for example, ask the students to summarize the problem under discussion, to propose a strategy for solving the problem, or to state and defend a particular solution. The process is called "parallel polling" because all members respond concurrently, unlike the sequential type of polling that occurs in a traditional classroom. After the student responses are submitted, the instructor can either use the responses as a basis for group discussion or simply retain them for later evaluation.

There are two advantages to polling in this way. First, it allows the instructor to independently assess each student's reasoning and understanding of the problem. Second, it can enhance the performance of the group. Polling the group in this way resembles a methodology, known as "nominal group technique" used in group problem solving research to improve the productivity of a team (Van de Ven &

Delbecq, 1974). Nominal group technique has been found to improve both the productivity of the group and the group member's satisfaction with the problem-solving process (Hill, 1982).

Joint Production. Joint production is simply constructing a product as a group. The product can be a document, a drawing, a database, or some other form of artifact. In the past most joint production work in instruction has involved collaborative writing. Joint production can be accomplished in e-talk through chauffeured meetings. The scribe can use a variety of software applications to construct the group artifact—word processing software, hypertext programs, spreadsheet programs, graphic programs, and so forth. A hypertext outlining program like Owl Guide, for example, might be very useful for group planning of a document.

The chief benefit of conducting a chauffeured meeting using ESC is that each participant can compose their own contributions to the group product, as opposed to having their contributions be paraphrased by the group scribe. The network can also be used to save and distribute copies of the group product to members of the group at the conclusion of the meeting.

Managed Presentation. Realtime Writer, a commercial program for synchronized computer-mediated communication, offers a special window known as a "teacher" window (Beil, 1989). Teacher windows are used to present material to students in a controlled way. Teacher windows could be easily implemented in e-talk by establishing a multi-way dedicated channel of communication from an instructor's dispatch window to each of the students.

The idea of teacher windows may seem like a regression to the old teacher-centered model of instruction—the teacher using the network to deliver knowledge. There may be situations in a collaborative classroom, however, in which it would be useful to be able to present material in a managed way to the group. An example would be presenting source materials to the group for discussion and analysis (Fletcher, 1989). Also, teacher windows need not always be used by teachers. The cooperative learning method known as "Jigsaw" (Slavin, et al., 1985) involves dividing a learning task among the members of a group. Following a period of independently researching a topic, a student could use a teacher window to share resources and findings with members of the group. Distributing material electronically eliminates the need for note-taking and provides meeting participants with a copy of material that can be carried from the meeting.

Socratic Tutoring. Another method of computer-mediated interaction discussed in the literature (Bruce and Peyton, 1991) is so-called "Socratic tutoring" in which the teacher engages in electronic dialogue with each student. In this method, the instructor poses queries to the group as a whole and provides feedback to each person individually. The technique begins as parallel polling, but then progresses to a private electronic conversation between the instructor and student. Because the nature of the activity is individualized instruction, teacher to student, this is, strictly speaking, not a collaborative method of instruction. However, it could be used within the context of other collaborative activities, and hence its presentation here.

Implementation of Socratic tutoring is slightly more complicated than the previous examples. It is done using a combination of dedicated channels and open-forum conversation as shown in Figure 4. In this arrangement, each student has a Dispatch window directed to the instructor's Listener window; the instructor has a Dispatch window corresponding to each student.

Discussion and Conclusions

Facilities for real-time computer-mediated communication have existed for some time. The talk facility built into the Unix operating system is an example of an early ESC program. The Chat Box facility in Aspects and the Quick Conference facility in QuickMail are two more recent examples of real-time conferencing facilities. Realtime Writer and Interchange are two commercial programs developed specifically to support synchronous communication in the networked classroom. The e-talk program was not developed to compete with these existing programs, but rather to provide a vehicle for further experimentation into the affordances of ESC within collaborative instruction. What it offers is a simple, but general model for supporting synchronous communications.

The idea of using ESC to support collaborative work in the classroom is not novel. Past uses of real-time conferencing in composition instruction, for example, have been summarized in Hawisher and Selfe (1989) and in Bruce and Peyton (1991). The shift here is from using computers for collaborative writing to the use of computers to support collaborative instruction generally. We are arguing that the techniques described above that have previously been used to develop writing skills in freshman English courses could be used with equal benefit to teach social studies in high schools, science in elementary schools, or preclinical medicine in a medical

schools. The common thread is using technology to support communication in the collaborative classroom.

It should be noted that ESC is not the only way of using software to support group work. Other forms of "groupware" (Stefik, et al., 1988) include group editors and screen-sharing software. Group editors allow members of a group to work concurrently on different components of a shared artifact, such as a report or a design. There is usually a locking scheme of some sort to prevent two participants from simultaneously updating the same component. Examples of group editing programs include ShrEdit (Olson, Olson, & Storrøsten, 1992) and the Aspects program (Watkins, 1991).[7] Screen-sharing software is a less common approach to supporting group work. Using a screen-sharing program, one participant can "logon" as a guest user on another's machine—both users then see the same screen and can interact through their keyboard and mouse. A commercial example of this type of application is the Timbuktu program for Macintosh computers.

Some of the techniques described for ESC provide functionality similar to that provided by group editing and screen-sharing software. The purpose of the chauffeured meeting is to combine individual work into a common product. In this case, the person "facilitating" the meeting serves the role of the locking mechanism in a group editing program. Screen sharing is a useful technique for getting the full group to focus on one task, for demonstration of new tools, or for monitoring group progress when subgroups are working independently. Screen sharing is implemented in e-talk through the introduction of a projection system.

This is not to argue, however, that e-talk can serve as an omnibus tool for real-time conferencing. There are trade-offs involved in the methods described for supporting group editing and screen sharing using e-talk. For example, although chauffeured meetings can produce a group product, they require that the work be filtered through one individual. This may not always be desirable. Also, designating one person to be the scribe removes (or at least diminishes the role of) that person as a contributing member of the group. Adding a projection system that will work with high-resolution displays is an expensive proposition. If screen sharing is an uncommon method within a group, it may be more cost-effective to implement screen sharing using software. The optimal approach, therefore, to

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[7] The "publish and subscribe" feature recently added to the Macintosh operating system is an example of group editing supported at the level of the operating system.

using groupware to support collaborative instruction may be one which provides a variety of tools—allowing the group to select the most appropriate one for the job.

In the traditional classroom, "passing notes" among fellow learners is considered an infraction of the rules and is grounds for a detention. This policy is turned on its head in the collaborative classroom. Communication among learners is a valued (and even essential) part of student work in these settings. Electronically-supported conversation represents an attempt to use technology to enhance this type of communication.

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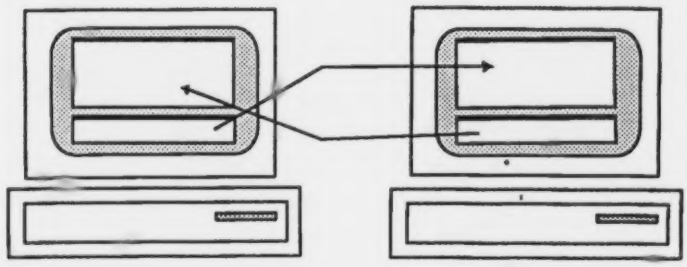

Figure 1: A dedicated channel of communication.

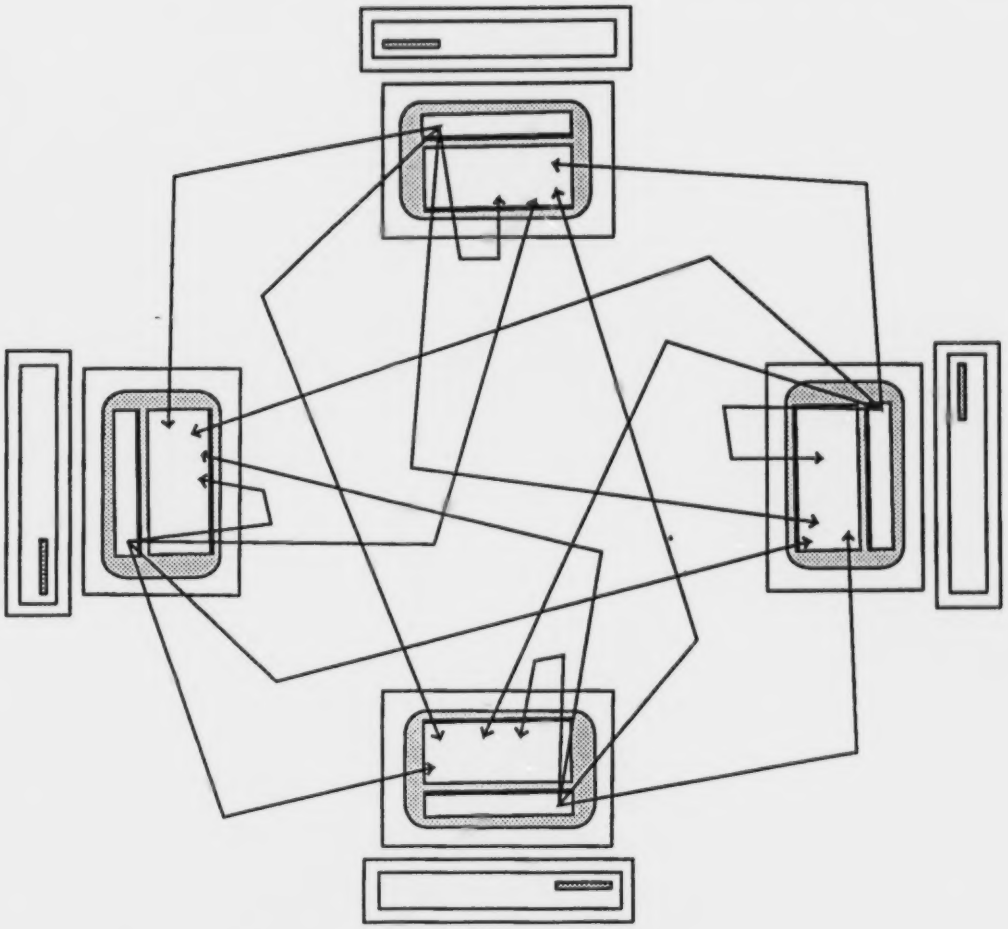

Figure 2: Open-forum communication using e-talk.

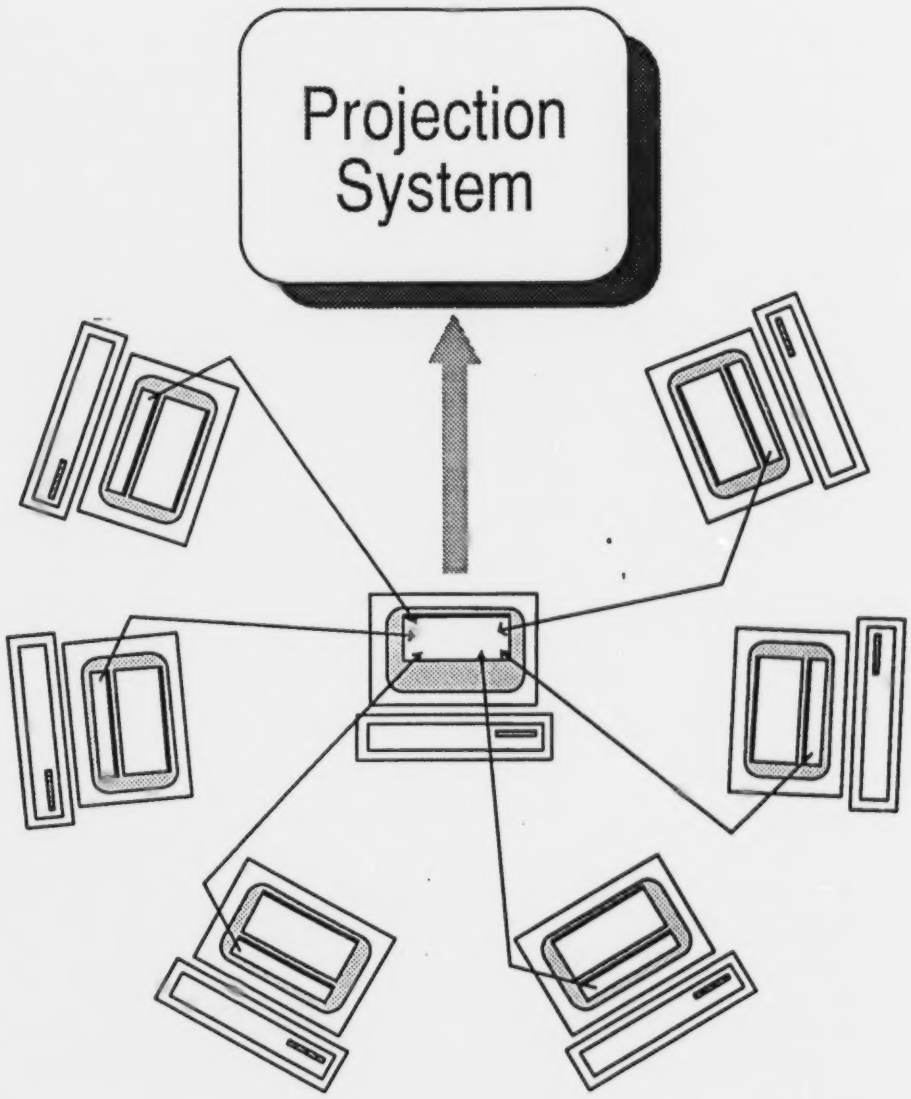

Figure 3: Chauffeured meeting using e-talk.

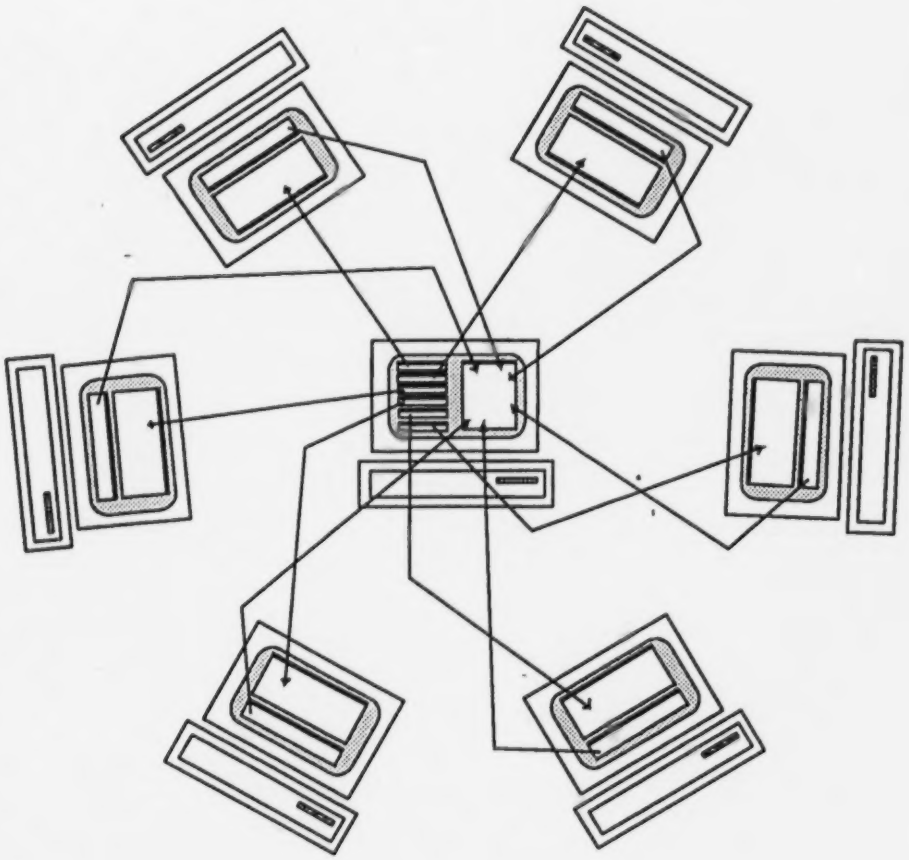

Figure 4: "Socratic tutoring" using e-talk.